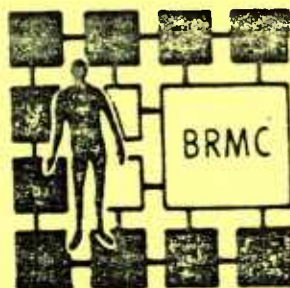


# SEMIANNUAL BUSINESS RESEARCH REPORT

AD A047430

A Compendium Prepared By:

Air Force Business Research Management Center



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Air Force Business Research Management Center  
Wright-Patterson AFB, Ohio 45433

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Prepared under the authority of AFR 20-5

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\*\* Featured research area for this issue.

## GENERAL INFORMATION

The Air Force Business Research Management Center (AFBRMC) is a focal point for acquisition-related research studies. Operating under the functional guidance of Headquarters USAF/LGP, AFBRMC matches acquisition problems with existing research capabilities; manages/monitors selected research efforts; tests research results; and when warranted, assists in implementing resulting recommendations for improvement.

This report has two purposes: communicating research results to acquisition managers; and providing challenging issues for study to potential researchers. To provide a framework for conceptualizing the acquisition process, AFBRMC has defined the following "acquisition practices":

Requirements Generation - Processes of establishing needs to be satisfied by acquisition.

Business Strategy - All processes involving establishment of business management plans, contractual relationships, and alignment of specific Air Force functions affected.

Program Management - Processes of planning, organizing, and controlling internal activities to insure that contracted program needs are satisfied.

Logistics - Processes related to life cycle system support.

Business Environment - Processes employed to permit acquisitions to accommodate external pressures and market conditions.

These practices describe continuing activity which goes on throughout the life cycle of any acquisition project. Acquisition practices are then divided into research areas and subdivided into research projects. Each research area is managed by an AFBRMC research associate or assistant who is responsible for relating the on-going research effort to the total area of concern. The research area manager also helps operating managers and potential researchers assure that their knowledge base is current and complete. The various research areas currently managed by AFBRMC are reported in Sections 1 and 2.

To increase the depth of information provided in each research area, this issue begins a practice of staggered coverage. Specific research areas will be reported in this issue with the remaining research areas to be covered in the alternating Semiannual Business Research Report. Areas selected for this report are listed in Section 1. In addition, certain research areas have been selected for in-depth coverage in each issue. These are indicated by a double asterisk (\*\*) in the Table of Contents.

#### HOW TO USE AFBPMC:

For the Air Force Manager: AFBPMC serves as a consultant to the acquisition community. In this role, we can provide you with information concerning previous or current research. We can also act as your interface with professional researchers and can help locate research resources to work specifically on problems of interest to you. Where you believe that the results of research dictate a change in policy or procedures, we can help prepare implementation plans.

For the Researcher: AFBPMC can help researchers by providing a source of practical problems and policy issues which are significant and worthy of study. We can also assist in defining larger issues into specific problems; obtaining bibliographic material with regard to specialized areas of concern; establishing contacts; and, in many cases, locating and obtaining necessary data.

Inquiries: Direct communication with the AFBPMC is authorized and encouraged. To bring a problem to the AFBPMC's attention or secure the consulting services of an AFBPMC research manager, simply call us at Autovon 787-2851 or Commercial 513-257-2851. You may also employ an Air Force Form 571, Procurement Research Note, to bring a specific problem to our attention. If this is unavailable, a letter to AFBPMC/LGPB, Wright-Patterson AFB, Ohio 45433, will receive prompt attention.

#### SOURCES OF INFORMATION

##### Historic:

Completed studies and background material can be obtained from the Defense Logistics Studies Information Exchange (DLSIE) and the Defense Documentation Center (DDC).

DLSIE maintains a current and historical inventory of logistics studies information about logistics models and related documentation of significance to the research and management of logistics. Specific studies can be requested by referencing the "LD" numbers cited in this report. Background information can be obtained by inquiries using "key words" to identify the area of interest. Bibliographies of background material and microfiche copies of documents can be obtained from:

Defense Logistics Studies Information Exchange (DLSIE)  
US Army Logistics Management Center  
Fort Lee, Virginia 23801  
Autovon 687-4546, Area Code 804-734-4546

Specific studies can be obtained from DDC by citing the "AD" number of the desired report. Background information can be obtained by using "key words" to identify areas of interest. Bibliographies of background information and microfiche copies of documents can be obtained from:

Defense Documentataion Center (DDC)  
Cameron Station  
Alexandria, Virginia 22314

For custom bibliographies, contact Autovon 284-6867, Area Code 202-274-6867. For individual documents, contact Autovon 284-7633, Area Code 202-274-7633.

#### Current:

Information concerning studies in progress can be obtained from AFBRMC/LGPB, Wright-Patterson AFB, Ohio 45433, Autovon 787-2851, Area Code 513-257-2851; USAFA/DFEGM, USAF Academy, Colorado 80840, Autovon 259-3067; or AFCMD/XRR, Kirtland AFB, New Mexico 87117, Autovon 964-0361, as appropriate.

BIBLIOGRAPHY OF PREVIOUSLY REPORTED RESEARCH: Beginning with this edition of the Semiannual Business Research Report, we are including a reference to studies previously completed and reported. This bibliography is organized by using the framework of research "practices" previously defined. Copies of most of the listed studies are available from DDC and/or DLSIE. Copies of those studies not followed by an "AD" or "LD" number can be obtained from AFBRMC.

## SECTION 1 - TOPICAL LISTING OF AFBRMC RESEARCH

<u>Practice/Area</u>	<u>Reported in Semiannual</u>
I. REQUIREMENTS GENERATION	
Support Acquisition	Winter Edition
Support Requirements	Summer Edition
Systems Requirement Management	Summer Edition
II. BUSINESS STRATEGY	
Contractor Motivation	Winter Edition
Role of the Contracting Officer	Summer Edition
Acquisition Communication	Summer Edition
Analysis of Disputes/Protests	Summer Edition
Impact of Foreign Military Business	Summer Edition
Procurement Productivity	Winter Edition
III. PROGRAM MANAGEMENT	
Business Management Systems	Summer Edition
Production Management	Winter Edition
Systems Cost Estimating	Summer Edition
Management Information Systems	Winter Edition
Design-to-Cost	Winter Edition
IV. LOGISTICS	
Reliability Management	Summer Edition
Industrial Base	Winter Edition
Life Cycle Cost	Summer Edition
Quality Assurance	Winter Edition
V. BUSINESS ENVIRONMENT	
Inflation	Winter Edition
Impact of Socio-Economic Programs	Winter Edition

## SECTION 2 - AFBRMC PROJECTS

- I. REQUIREMENTS GENERATION: Processes of establishing needs to be satisfied by acquisition.

### SUPPORT REQUIREMENTS

Area Manager: Captain Paul W. Gross, Jr.

Objective: To improve the wholesale/retail level support decision processes that allocate resources to improve the efficiency of Air Force operating and support functions. The primary areas of concern are requirements generation and inventory management and control. Requirements generation includes, but is not limited to, provisioning, spares computation, depot maintenance repair computation, and equipment requirements determination. Inventory management and control deals with depot/base interface and stock control and distribution policies.

Background: The USAF logistics support system involves the USAF, the Air Force Reserve, Air National Guard, other U.S. government agencies, and air forces of nations receiving U.S. security assistance. As of 1975, the Air Force Logistics Command (AFLC) managed a \$13.8 billion inventory with over 800,000 line items. The diversity of applications, operational concepts for deployments, and the number of items involved greatly complicate the managerial task. Resource allocation decisions in the total logistics spectrum (e.g., plans and programs, requirements, distribution, maintenance, and redistribution and marketing) impact the acquisition process. Before procurement action begins, basic questions of need, quantity, lead time, and cost must be considered. In our complex environment, the various questions are usually expressed in terms of models, many of which are automated. The automated models depend upon various types of computational techniques to reach approximately optimal decisions within specific constraints.

Significance:

Present Air Force automated computational techniques, system software, and Air Force policy can be improved by research. Means must be found to analyze the effects of constraints (e.g., fund limitations) on decisions. Studies should be directed toward refining support concepts, techniques, and procedures.

Several recent examples of contributions in this area which have improved the system are economic criteria of disposal decisions of expendable items by Captain D. Heidler and Captain R. Harris (see project C-2-3) and essentiality coding by Captain Carlburg (see December 1975 Semiannual). The disposal decision study model is in the process of being implemented into the AFLC system with certain modifications. The essentiality coding study was a concept study which highlighted a problem and provided suggested improvement to the system, it requires extensive staffing before acceptance. However, the research provides the necessary first step.

Projects Completed(\*)/In Progress:

\*1. Project Number C-2-3, "Disposal Decisions," Captain D. Heidler and Captain R. Harris. AFIT/SL Thesis. Chairman: Major D. Rippy. (AD A016345)

a. Summary: The research developed a model, based upon economic criteria, for determining the economic retention level for expendable (EOQ) type items managed by Air Force Logistics Command (AFLC). Sensitivity analysis of the model showed that storage costs and net income from sale of excess assets were the most significant parameters of the disposal decision. Using present AFLC inventory cost factors, the model indicates that retention levels for assets with low probability of demand should be much longer than those previously used for disposal decisions.

b. Significance: The model aids management decision-making by balancing discounting holding cost incurred when items are retained and discounting ordering cost incurred when items are disposed. Thus, the model reflects the economic feasibility of maintaining existing items in the inventory in anticipation of future demand in lieu of disposing the items and reprocurring. The sponsoring agency (AFLC/LORRS) is in the process of implementing this model with certain modifications.

2. Project Number C-2-6, "Variable Obsolescence," Captain M. Anselmi, USAF Academy faculty. AFBRMC Sponsored. Research Director: Captain P. W. Gross, Jr.

Summary: This study, which is being cosponsored by AFLC, is analyzing and developing a revised variable obsolescence matrix. The original variable obsolescence matrix proposed for incorporation into the Air Force economic

order quantity (EOQ) model did not include disposal of excesses. The technique being developed computes obsolescence factors for each weapon system/federal stock class relationship. Scheduled completion date is December 1976.

3. Project Number C-2-7, "Inventory Taxonomy." AFBRMC Sponsored. Research Director: Captain P. W. Gross, Jr.

Summary: The problems of increased lead times, reduced sources of supply, and the effect of inflation have led to a degradation of the support positions of many critical assets. For example, increasing lead times on engine spares have disrupted depot maintenance schedules. If inventory assets could be coded by materials contained or production processes, lead times could be updated for like items based upon current market experience. Therefore, at the request of Headquarters AFLC/LORR, the AFBRMC prepared a research proposal to define the supply factors (price, lead times, sources, etc.), product factors (production techniques, materials, etc.), and demand factors that can be coded and utilized in an inventory system. It was proposed that the study classify, precisely define, and code the components within a sample engine assembly. This concept would permit management to adjust decision processes on an exception basis in response to, or in anticipation of, a changing environment. The proposal recommends that the research be done by a multidisciplinary team of AFIT-civilian institution students and university faculty members, under Air Force contract. The Management Science Office (XRS) is the AFLC OPR.

4. Project Number C-2-8, "Multiechelon Inventory Policies," Dr. L. Schwarz, University of Rochester. AFBRMC Sponsored. Research Director: Captain P. W. Gross, Jr.

a. Summary: The current USAF policy for managing depot-base inventories of nonrepairable spares is examined and compared with three alternative policies via computer simulation. The study evaluated the developing of a depot base system which has the same desirable properties of the current USAF policy, but (near) optimal from a cost and/or back order performance standpoint. The three alternative policies that were evaluated are: (1) system myopic variant to current USAF policy, (2) allocation policy, and (3) depot only policy (customer demand served directly by the depot--no base inventory).

b. Significance: Results indicate that the allocation policy alternative is significantly better than the other alternatives including the current USAF policy. The allocation policy uses the same depot and base order quantities and the same reorder levels as the current policy. However, whenever depot on-hand inventory falls below its reorder level, the depot enters a rationing mode, and remains in this mode until depot on-hand inventory rises above the reorder level again. The allocation policy attempts to spread the risk of a customer back order across all bases, and consequently improve the overall back order performance of the current policy. Because of the small sample used the results are tentative. Follow-on work is under way to expand and verify the original study.

\*5. Project Number C-2-9, "Cost Estimating Forecast of Support Spares," Captain E. Nelson and Captain W. Smith. AFIT/SL Thesis. Chairman: Lieutenant Colonel M. Martin.

a. Summary: This research explores ways of improving cost estimating methodology by developing a taxonomy of cost estimating characteristics which may be used as a guide in constructing and evaluating cost estimating models. The researchers defined a cost estimating characteristic as "a distinctive feature or attribute of a cost estimating model which may be used for descriptive, evaluative, analytical, or construction purposes." The guide was developed and applied to the construction of a conceptual model designed to estimate the replenishment investment spares budgetary requirement for AFLC.

b. Significance: The research developed a taxonomy of nineteen cost estimating characteristics (e.g., accurate, consistent, empirical, inclusive, practical, etc.) which was then used to evaluate the team's conceptual model and the present AFLC replenishment investment spares model. The research indicated the usefulness of a taxonomy of cost estimating characteristics by developing a methodology base so that a general cost estimation approach may be further developed. Also the research indicated that the present approach for budgetary estimates for replenishment investment spares could be improved and the team developed a replenishment investment spares cost estimating model.

\*6. Project Number C-2-10, "The Engine Actuarial System," Major R. Carlson and Mr. R. Smith. AFIT/SL Thesis. Chairman: Dr. R. Taliaferro.

a. Summary: This study examined methods for collecting historical engine data and the influence of various managerial planning decisions on engine maintenance workload

forecasts. Several representative engines with large and small inventories were studied. The team developed data handling tools which could be used by future researchers.

b. Significance: The researchers concluded that cluster sampling procedures could significantly reduce the number of bases required to report engine failure data. In addition, it was noted that small changes in the managerial decisions which establish planning factors related to flying hour program, maximum operating time (MOT), Jet Engine Base Maintenance Return Rate (JEBM/RR), and Dependability Index (DI) could significantly affect the actuarial forecast.

\*7. Project Number C-2-12, "Effect of Variable Safety Level of the D041 System on War Reserve Materiel Items in terms of Aircraft Grounding Incidences," Mrs. J. Denman, Captain J. Gavel, Captain P. Sholer. AFIT/SL Thesis. Chairman: Lieutenant Colonel Jones.

a. Summary: The research evaluated Air Force inventory policy for recoverable type items (D041, Recoverable Consumption Item Requirements Computation System) in terms of the impact of the variable safety level technique on aircraft grounding (NOR(S) G) incidences for War Readiness Spares Kits (WRSK) items. The variable safety level technique was intended to provide optimal inventory support for recoverable items. The problem addressed possible compromise of wartime operational support capability versus peacetime efficiency, as a result of incorporating the proposed variable safety level into the D041 System.

b. Significance: The research indicated under the variable safety level policy that support of critical items (particularly War Readiness Spares Kit items) may be degraded. However, data availability problems render the research results indicative rather than conclusive. Further research is required to verify the results, however, the data problems must be solved before additional research can be effective.

Research Opportunities: The topics in the support requirements area currently under consideration concern inventory management and control, provisioning, spares computation, depot maintenance repair computation, equipment requirements determination, and spares cost estimating.

## SYSTEM REQUIREMENTS MANAGEMENT

Area Manager: Major Lyle W. Lockwood

Objective: To establish a system acquisition requirements management strategy that will assure the achievement of acquisition objectives.

Background:

The system acquisition requirements process has long been the topic of high level study and top management, including congressional, attention. It is no exaggeration to state that requirements management is one of the most difficult problems facing acquisition managers today. The difficulty is increased by the fact that the term "requirements" is not clearly defined in a systems acquisition context. Consequently, emphasis has centered on the process and organizational aspects of requirements development and management.

Studies, to date, have resulted in improved understanding of the sequentially-oriented process. Top management's attention has been concentrated on refinements of organizational element roles in reviewing and evaluating acquisition requirements. The general flow of requirements has been judiciously charted. Directions and branches of flow have been established. Management controls and reviews have been defined and designed into the process like valves, gauges, and spigots in a pipeline. Institutional arrangements such as DSARC have been devised to address the control problem. In total, these efforts have done much to clarify and establish control of the process.

However, the requirements process and related management controls need a better means of addressing the varied contents of the requirements pipeline if they are to realize their intended potential.

System acquisition requirements can be divided into the following categories: (a) mission requirements, (b) operating characteristics, (c) design standards and specifications, (d) management system standards and specifications, (e) legal obligations, and (f) programming requirements. This categorization of requirements adds a third dimension to the requirements process flow--substance.

Cost and schedule impacts are associated with each requirement category and its attendant flow to satisfy use or control functions. It can be argued that cost and schedule can operate as an objective, i.e., a requirement, or as a constraint depending upon the situation. However, each requirement category clearly consumes both resources and time. Therefore, the relative cost of each requirement should and must be established in order to evaluate its worth.

Significance: Although the requirements process and its organizational dimension are dynamic, addition of a third dimension--requirements categories--to the process provides a framework to: (a) identify the total set of requirements that will be applicable/not applicable to an acquisition program, (b) determine the appropriate program phase to introduce requirement combinations applicable to a program, (c) assign the appropriate organizational element responsibility for evaluating a given set of requirements within a category, (d) assign cost and worth values to each requirement, and (e) analyze trade-offs and resolve conflicts for short-range versus long-range costs/benefits of requirements. There needs to be a unifying conception and classification system to improve management of acquisition requirements.

Research Opportunities:

1. Is the aforementioned classification of requirements valid and complete?
2. What is the form, cost, and benefit of each category of system acquisition requirements?
3. What is the appropriate acquisition phase to introduce each category of system acquisition requirements?
4. What are the costs and benefits of the specification tailoring process as applied to design standards and specifications? Can the process be expended to other requirement categories?

- II. BUSINESS STRATEGY: All processes involving establishment of business management plans, contractual relationships, and alignment of specific Air Force functions affected.

#### ROLE OF THE CONTRACTING OFFICER

Area Manager: Captain Jerry D. Price

Objective: To provide the knowledge base needed to increase the effectiveness of Air Force contracting officers.

Background: A proliferation of legislation and regulations, evolution of new organizational concepts, and changing technological and socio-economic factors have combined to limit the application of a contracting officer's judgment. It has been stated that the objective of a contracting officer is to buy with the least risk of criticism, instead of buying with efficiency and effectiveness. The Commission on Government Procurement stressed the need for allowing contracting officers to exercise business judgment in representing the government's interest and for assuring that authority is exercised by qualified individuals.

Significance: Today's business environment, increasing weapons system acquisition and support cost, and tight fiscal constraints mandate that contracting officers be highly qualified and properly motivated. The apparent loss of contracting officer authority and the associated loss of confidence in procurement itself make it difficult to attract highly motivated people to the field.

#### Projects Completed(\*)/In Progress:

\*1. Project Number AD B011894L. "AFLC Contracting Officers: What They Think About What They Do," Major L. D. Cox, Air Command and Staff College.

a. Summary: This study presents empirical data on job satisfaction derived from a survey of 147 AFLC contracting officers. After addressing the specific dimensions of job satisfaction, motivation, and skill utilization, the study recommends the establishment of a job enrichment program based upon Dr. Herzberg's motivator-hygiene model.

b. Significance: This study provides an excellent beginning of the descriptive phase requisite for developing and implementing any role enhancement program.

\*2. Project Number LD 36067A. "Roles of the Procuring and Administrative Contracting Officers (PCO and ACO) in the Administration of Weapon Systems Contracts," Major T. D. Wanner, Air Command and Staff College.

a. Summary: Examining "less than major" programs, this study addressed the nature and extent of conflict between the PCO and ACO during the production phase of weapon systems acquisition. While conclusions were limited due to the small data base, the study highlights problems in maintaining the "single face to industry" concept, PCO involvement in plant activity, the use of memorandums of understanding, and identifies issues of role identification.

b. Significance: It has been stated that there are role conflicts between the PCO and ACO in systems acquisition. This study does identify some problems in a limited situation; however, the conclusions are not generalizable. Follow-on study to include a larger data base and recommendations for reducing conflict is needed.

#### Research Opportunities:

- (1) What are the existing roles of contracting officers?
- (2) What should the roles be?
- (3) What are current/projected role deficiencies?
- (4) What enhancements can alleviate the deficiencies?

### ACQUISITION COMMUNICATIONS

Area Manager: Captain James J. Dunlap

Objective: To improve the communication process between the Air Force and potential contractors.

Background: Solicitation documents must be adaptable to a variety of different procurement types (systems, central, or base). In the case of RFP's/IFB's, solicitations must also be contractually correct. This research area covers a multifaceted problem involving the communication of requirements

between the Air Force and its sources. One facet of the problem concerns the policies, procedures, and documents available to contracting officers. Another deals with communication theory, i.e., the purpose of solicitations is to facilitate two-way communication. On the one hand, Air Force requirements must be clearly communicated to prospective offerors; on the other hand, each offeror's response must be understood by the contracting officer. A final facet concerns those behavioral aspects that are a function of government personnel training and experience, or of an offeror's motivation and response patterns.

Projects Completed(\*)/In Progress:

\*1. Project Number A-2-1-74. "Purchase Communications: A Study of the Request for Proposals." Colonel C. V. Hynes (USAFRes, Ret.), Ph.D., University of Maryland. AFBRMC Sponsored. Research Director: Captain J. J. Dunlap.

a. Summary: This report reviews the literature pertaining to the Request for Proposal and then presents the findings of a study designed to solicit opinions about the Request for Proposal from contract administration officers of the 108 largest defense contractors for 1974 (actual response rate was 67%). Respondents were presented with a list of 23 statements requiring one of five responses ranging from "strongly agree" to "strongly disagree." The study presents the results of the survey, as well as comments offered by many of the respondents.

b. Significance: This study provides an industry viewpoint of the Request for Proposal that will be of interest to those involved in government procurements.

ANALYSIS OF DISPUTES/PROTESTS

Area Manager: Captain James J. Dunlap

Objective: To investigate, document, and recommend solutions for problems which have led to protests and disputes.

Background: DOD contractual documents contain provisions relating to protests and disputes. The disputes clause, for example, may apply when the contractor and government representatives cannot reach agreement on some question of fact. In such cases, the contractor may eventually file an appeal with the Armed Services Board of Contract Appeals

(ASBCA). The Air Force Logistics Command (AFLC) Judge Advocate is responsible for reviewing Air Force contracting officer's final decisions and defending such cases before the ASBCA. Review of past protests and dispute situations to determine procurement practices that require improvement will add to our problem prevention capability and will assist in pinpointing topics suitable for future research effort.

Projects Completed(\*)/In Progress:

\*1. Project Number A-3-2-75. "Inquiry into the Contribution of Contracting Parameters to Contract Disputes," Captain J. B. Baxa and Mr. P. Hicks. AFIT/SL Thesis. Chairman: Major L. Zambo.

a. Summary: This thesis addressed the possibility that factors both within and outside of contract provisions might provide impetus for a contractor to seek settlement of a dispute from the ASBCA. Two levels of analysis were performed. The first level was a proportional comparison of selected variables occurring in a sample of DD Form 350 records on contracts of disputes cases with a sample of DD Form 350 records on contracts that were not disputed. Second level analysis involved a determination of whether or not interrelationships and dependency existed between variable subcategories. A statistically significant relationship was found to exist between the occurrence of dispute appeals and each of the variables such as total contract value, contract type, total annual sales, business size, labor surplus area, type of work, and type of product. The authors' overall conclusion was: Dollar value of the contract probably does not represent a measure of contractor risk but may indicate the willingness or the ability of the contractor to appeal a disputed issue. Business size is directly associated with the occurrence of appealed disputes regardless of the size of the claim. The contract dollar value generally establishes an upper limit for the dollar value of the claim, but it is not an indicator of the size of the claim. Contractors located in labor surplus areas tend to be motivated to actively pursue the appeals process. The complexity and uncertainty of the technology was directly related to appealed disputes.

b. Significance: This study is part of an effort to identify characteristics of disputes situations such that problems can be prevented before they occur. It follows a previously reported study, Newman (1975), and reflects considerably more success in statistically analyzing appeal

data. The results of most interest concern the first level analysis wherein variable proportions in the appeal contract sample are compared with a control contract sample.

\*2. Project Number A-3-3-75. "Civil Engineering Service Contracts: Relationship of Performance to Contract Type," Captains G. C. Ehnert and D. W. Kaiser. AFIT/SL Thesis. Chairman: Lieutenant Colonel G. Bolen.

a. Summary: The purpose of this research effort was to determine whether service contractor performance is significantly related to the type of contract involved. The research hypothesis asserted that contractor performance is related to contract type. Contractor performance was expressed by the number of documented instances of unsatisfactory performance. Contract type was defined as distinguishing between fixed price and incentive price contracts. Several other factors were also considered, such as contract cost, scope, and term, as well as contractor experience and stature. Data were collected from nine Air Force installations and input to a stepwise linear regression program. The resultant equation was subjected to F- and t-tests to establish overall and individual statistical significance.

b. Significance: As analyzed, the data did not support the original research hypothesis that contractor performance is related to contract type. This is of interest because there is considerable discussion among procurement personnel about what type of contract best suits civil engineering-related requirements. Further, the study identified two other factors which did significantly affect contractor performance. These were the use of small business set-asides and the transition period from in-house to contractor performance. It is useful to have objective support for what may be "intuitively" felt by many procurement personnel.

## IMPACT OF FOREIGN MILITARY BUSINESS

Area Manager: Captain James J. Dunlap

Objectives: Examine, define, and understand the implications of foreign military business (FMB) on the U.S. defense acquisition process. From such study, extract ideas and recommendations directed toward the management policies and procedures used to cope with Air Force involvement with FMB.

Background: The FMB area can be considered to include three parts: (a) foreign military sales (FMS), (b) international cooperative programs, and (c) grant aid. These three parts describe major types of FMB activity. Nevertheless, the AFBRMC feels it is necessary to apply further effort to organization of the research area to arrive at the major issues that currently impact the defense acquisition process. Specifically, the FMB area can be considered to incorporate the following topics which transcend each of the three parts discussed above:

a. Conflict Resolution Process. The thrust of this topic is managerial in nature, i.e., the objective is to manage conflict. The major issue concerns negotiations involving memoranda of understanding, price and availability data, and letters of offer and acceptance.

b. Impact of FMB on Procurement Policy and Procedures. Organization for effective procurement support where international participation is involved is a major issue under this topic. Other issues include the application of various statutes, ASPR provisions, etc., to FMB situations; acquisition planning when requirements other than those of U.S. forces are included.

c. Management of International Programs. Many major issues fall under this topic: coproduction and codevelopment; rationalization/standardization; offset management (incorporating procurement from foreign sources); technology transfer and foreign disclosure; and binational, multinational, or consortium management efforts.

d. Logistics Support. Inevitably, each of the three aspects of FMB result in a requirement for logistics support. Thus, a major issue is the cooperative logistics support system maintained by AFLC. Elements of this issue include support alternatives, financial management, and such things as transportation and communications. Also involved is the area of AFSC/AFLC interface and the subjects of product support and the engine CIP program.

Significance: Sales of military items are of interest because of the effort required to cope with the increasing dollar value and number of actions involved, and the ensuing impact on the acquisition process. International cooperative efforts such as coproduction and codevelopment promise to be in demand by countries desiring to reduce foreign exchange outflow while upgrading their technological capability. Further, projects of the magnitude of the F-16 pose substantial management challenges. The final part, grant aid is of declining importance, but may retain residual interest due

to the inability of some allies to transition to the purchasing mode for satisfying defense needs.

Projects Completed(\*)/In Progress:

\*1. Project Number A-4-2-75. "Foreign Military Sales: A Study of the Preparation of the United States Department of Defense Offer and Acceptance (DD Form 1513) for a USAF Major Weapon System Package Sale," Captain R. D. Materna. AFIT/SL Thesis. Chairman: Dr. L. Norton.

a. Summary: The instrument which defines the terms and conditions of the sale of U.S. military goods and services to a foreign customer is the U.S. DOD Offer and Acceptance (LOA). This thesis examines procedures for preparing the LOA for a USAF major weapon system package sale to insure that this document does represent a complete and accurate contract, satisfactory to the customer, the contractor, and the U.S. government. The thesis covers in detail the procedures for processing a USAF major weapon system sale and a description of the actual LOA. A substantive chapter provides a review and analysis of: LOA policies and procedures; FMS organizational relationships and responsibilities; and interaction between the customer, contractor, and U.S. government. The preparation of the LOA for the F-16 cooperative sale to participating European countries is reviewed. Based upon his study and analysis of structured interview results, the author concludes that the most recurring problems occur in the areas of (in descending order of importance): (i) initial planning during LOA preparation; (ii) lead time for the determination of accurate price and availability data; (iii) early MAJCOM involvement during sale planning and coordination; and (iv) coordination during LOA preparation, subsequent to initial sale planning.

b. Significance: This thesis presents an up-to-date discussion of many substantive issues involving LOA's. It incorporates the findings of recent study groups (i.e., the Systems and Resources Management Action Group) up through early 1976. As such, it can assist in providing insight into the unique and complex relationships found in FMS and provide background understanding which may assist FMS personnel in avoiding problems encountered in past LOA negotiations.

\*2. Project Number A-4-3-75. "An Examination of the NATO Maintenance and Supply Organization," Major C. F. Carver and D. H. Walsworth. AFIT/SL Thesis. Chairman: Dr. L. Norton.

a. Summary: A current U.S. foreign policy objective is to increase the self-sufficiency of other free-world nations through military sources. The authors contend that, to be self-sufficient, nations should be capable of providing a majority of defense requirements from within their own industrial, economic, and technological base. Within NATO, the NATO Maintenance and Supply Organization (NAMSO) exists to provide effective logistics support for common weapons systems and equipment operated by two or more NATO countries at minimum cost to those countries. This concept of operation appears to contribute to member country self-sufficiency. The authors examine the history, purpose, structure, and functions of NAMSO and evaluate the effectiveness of NAMSO in meeting its stated mission and objectives, and in contributing to the self-sufficiency of its members. The authors develop eight overall goals which form the basis for the NAMSO evaluation. It is concluded that, while NAMSO has contributed to member self-sufficiency, changing circumstances should cause NAMSO to reevaluate its role in providing future services to customers. Several recommendations toward this end are offered.

b. Significance: The increasing burden of supporting (via cooperative logistics support) products delivered to U.S. allies through FMS and grant aid is of major concern to the Air Force. Increased self-sufficiency on the part of customer countries is one possible means of alleviating the problem. This evaluation of NAMSO highlights the necessary criteria and problems associated with regional cooperative support efforts. Further, this thesis is particularly timely in view of contemporary emphasis on NATO rationalization/standardization, and concern about future operational support of the F-16.

\*3. Project Number A-4-5-75. "The Evolution of the Foreign Military Sales Program and Its Impact on Defense Procurement Policies and Procedures," Major J. L. McChesney, AFIT/CID, George Washington University. Research Director: Dr. H. Page. (AD A026854)

a. Summary: The overall objective of this dissertation is well conveyed by the title. The author reviews the evolution of FMS to include a review of security assistance legislation and a discussion of trends relative to FMS (increase

in purchase of complex items, etc.). The defense procurement process is reviewed with emphasis on critical determinations that affect FMS and significant differences between FMS and DOD procurements. A discussion of FMS procurement problems covers planning, source solicitation, selection and award, and contract administration. The author follows his problem analysis with a discussion of policy alternatives and suggested procedural revisions. He also considers various ways of organizing procurement to cope with FMS (e.g., separate organization, major policy/procedure modifications, and minor policy/procedure modifications) and defends the conclusion that the minor modification approach is most advisable.

b. Significance: This dissertation offers the most comprehensive review of FMS relative to the defense procurement process presently available. Besides his literature review, the author consulted with 57 operative and executive FMS/procurement personnel. The problem analyses presented are complemented with an extensive list of recommendations. More importantly, the discussion is organized such that it is possible to review only those parts of the dissertation that are of particular interest to the reader.

4. Project Number A-4-6-75. "Collaboration in Technology: An Analysis of Transnational Program Management," Major N. B. Ohman, AFIT/CID, University of Texas-Austin. Research Director: Mr. A. Shapero.

Summary: This research will examine the issues and processes of transnational research and development programs and their management. An interim paper based upon an examination of the empirical data available to the researcher in October 1975 provided insight to his direction. In that paper, the researcher identified economic, political/legal/military, cultural/communication, and management issues in a matrix format to reflect interrelating impacts at specific program phase points. Tentative conclusions point to an increasing role for transnational programs; new political, economic, and cultural uncertainties; and the need for new management initiative to prevent the problems of history from being repeated. To address these observations, the researcher recommended early establishment of the rules of the game, the development of a program orientation in the transnational program team, limiting the agencies having direct contact with the program manager, and establishing an "international expertise gate keeper" for the program manager. Expected completion date is early 1977.

5. Project Number A-4-7-76. "Security Assistance - An Analysis of Its Importance and Problems in Communication and Data Interface," Captain A. Frazier and Captain R. Ray. AFIT/SL Thesis. Chairman: Dr. L. Norton.

Summary: This thesis addresses the critical subject of follow-on support for equipment given or sold to foreign countries. The problem addressed is that very little comprehensive information exists on the specific nature of security assistance recipient country logistics and communications systems. The overall objective of this effort is to establish a data base upon which the requirement for an integrated USAF international logistics communication system can be based. Research questions being addressed involve determining common factors that exist in selected security assistance countries to indicate whether or not there is a requirement for an integrated international logistics communication system and to assist in the design of such a system. Anticipated completion date is late 1976.

6. Project Number A-4-8-76. "An Exploratory Study of the Post Delivery Indirect Product Support Tasks for the F-5 Program," Captain J. P. Dutcher. AFIT/SM Thesis. Chairman: Lieutenant Colonel Letzkus.

Summary: Post delivery product support for FMS systems involves costly tasks over long time periods. It particularly becomes an issue after production ceases and product support expenses can no longer be assessed against production aircraft. The purpose of this thesis will be to define what constitutes post delivery product support for the F-5 program, identify the tasks which are performed to provide such product support, and develop criteria whereby these tasks can be identified and categorized. Anticipated completion date is late 1976.

Research Opportunities: From the AFBRMC viewpoint, matters such as the balance of world power or implications of foreign usage of U.S. arms are not within the scope of researchable issues. Further, it appears that there is little need for emphasis on work such as overall FMB program reviews. The reasons are that descriptive FMB work is well-established, and efforts that cover broad subjects yield little in the way of policy/procedure implementable results. Higher pay-offs are anticipated from studies wherein researchers are matched with reasonably specific problem situations. There also is a need to document specific program strengths and/or weaknesses, as although many FMB decisions cannot wait upon research study recommendations, research can perform a valuable critique function.

1. Aspects of International Procurement and Cooperative Weapon System Programs. The trend in foreign military business is toward more U.S. cooperation with foreign firms and governments. Foreign governments are interested in coproduction and codevelopment; offset obligations and increased emphasis on NATO rationalization/standardization may require USAF foreign source procurements of sophisticated military and commercial items. Research in the following areas would assist with the USAF effort to successfully cope with this trend:

a. Investigate the management aspects of international organizations to expand previous studies, and provide the USAF with the benefit of knowledge available in the multinational business literature.

b. Evaluate government multinational efforts and compare/contrast them with those in the private sector.

c. National differences pervade economic systems, personnel management, labor relations, business and production practices, etc. Analyze one or more of such topics to determine their effect on multinational production management and the competitiveness of foreign sources.

2. Aspects of Commercial Channel Foreign Military Sales. Congress' expressed position is that foreign military sales (FMS) should be handled via commercial channels. Because of this opinion, DOD may find it difficult to obtain certain compensations for the FMS workload now being handled. Study of areas relating to commercial sales versus FMS will assist in verifying the relative merits of alternative courses of action, and increase the DOD's capability for elucidating its position. Specific topics in this general area include:

a. Feasibility of commercial logistics support, to include assessment of contractors' willingness to provide direct service and comparisons on such matters as price and availability impact.

b. Comparative analysis of Air Force cooperative logistics support and that provided by commercial corporations on large scale aircraft or equipment systems.

3. Financial Management Techniques for FMS: A Comparative Analysis. Directed policy concerning FMS is that, to the extent possible, all costs to the United States government are to be recovered. This includes administrative costs, as well as the purchase of the actual end items. In handling FMS transactions, the services have adopted different

approaches: the Air Force allows a reimbursement method, while the Navy utilizes a trust-funding concept. A comparative analysis of these approaches would serve to illustrate procedural differences and advantages/disadvantages.

4. Additional topic ideas can be found in the "Recommendations for Further Research" sections of recently completed FMB research studies.

III. PROGRAM MANAGEMENT: Processes of planning, organizing, and controlling internal activities to insure that contracted program needs are satisfied.

#### BUSINESS MANAGEMENT SYSTEMS

Area Manager: Captain James J. Dunlap

Objective: To determine the management information systems needed by today's program managers.

Background: A number of management systems exist which a program manager can (or must) use in an acquisition program; however, not all are appropriate for a given situation. Such methods as C/SCSC, milestoneing, network analysis, and periodic program reviews are commonplace, yet programs using them continue to experience mixed results. Problems in the area can generally be viewed from two perspectives. First, what is (and how do we achieve) the proper balance between system need, implementation and maintenance effort, and desired results? Second, what are the limits of a system's capacity for satisfying management needs across a variety of programs and for multiple layers of decision-makers?

Projects Completed(\*)/In Progress:

\*1. Project Number B-1-5-75. "The Adequacy of Performance Information Provided to Department of Defense Managers in the Reports Required by the Selected Acquisitions Information and Management System (SAIMS)," Captain R. E. Green and Captain W. H. Renninger, III. AFIT/SL Thesis. Chairman: Captain D. Wright.

a. Summary: The objective of this study was to determine if the application of C/SCSC and the associated SAIMS-required reports insured that DOD managers were provided with useable performance information. The authors developed 14 criteria, based upon a survey of management literature and DOD directives. To measure the useability of performance information, the criteria were applied in an evaluation of actual reports generated in the management of two weapon systems contracts. Three categories of reports made up the data sample: SAIMS reports, contractually-required reports, and other reports. The study conclusion was that the SAIMS-required reports were capable of satisfying the performance information needs of DOD managers at the Systems Program Office and lower levels; however, at management levels above the Systems Program Office, other reports were required.

b. Significance: A large part of this thesis is devoted to discussion of the methodology for applying criteria tests to arrive at support/nonsupport of the research hypothesis. Notwithstanding this fact, there are some good insights into the application of SAIMS and C/SCSC to weapon system production contract situations. The interested reader would do well to review this thesis in conjunction with the Ray/Spicer thesis (AFIT/SL, August 1975) in which somewhat different conclusions were reached.

2. Project Number B-1-7-76. "Application of the Cost Performance Forecasting Concept and Model (ASD Cost Research Report 117) to Non-Air Force Data," Mr. Arthur Karsch, ASD/ACCX.

Summary: Cost Research Report (CRR) 117 presents a cost forecasting method with the objective of forecasting Estimates at Completion (EAC's) each month, utilizing data available in the Cost Performance Report. The CRR 117 model was developed based upon ASD weapon system program data. In this project, program data relative to the Army Heavy Lift Helicopter will be processed as an additional validation test of the model. Anticipated completion date is early 1977.

## SYSTEMS COST ESTIMATING

Area Manager: Captain Jerry D. Price

Objective: To improve the validity, accuracy, and reliability of cost estimates.

Background: Cost estimates have a wide variety of applications in the systems acquisition process. Estimates are used for life cycle cost analysis, for budgeting purposes, and to establish baselines for negotiations, performance measurement, etc. The importance of improving cost estimates has generated continuing research to better understand cost relationships and to increase validity, accuracy, and reliability of projections based on the relationships. The traditional approach of developing cost estimates is to extend accounting data by statistical methods. Using historical accounting data, which statically captures many dynamic variables such as economic conditions, effects of post-estimate controls, etc., causes many problems when trying to develop valid, accurate, and reliable estimates under the often different dynamic influences of a particular system acquisition. More recent research has tried to recognize uncertainties and lack of information by applying the concept of entropy to cost estimating. Research suggest that cost and risk analysis based upon technical unknowns can be combined to reduce estimating errors.

Significance: Since cost estimates have a variety of applications, it is readily apparent that their improvement will have significant impact on the system acquisition process. In addition to immediate improvements in acquisition, the Air Force could enjoy increased credibility with Congress and the public sector.

### Projects Completed(\*)/In Progress:

\*Project Number B-3-7-75. "Estimating Aircraft Engine Acquisition Costs," Captain R. Mullineaux and First Lieutenant M. Yanke. AFIT/SL Thesis. Chairman: Lieutenant Colonel M. D. Martin.

a. Summary: This study examined current parametric models used to estimate engine cost for aircraft. The authors concluded that currently used methods can be improved and recommended a methodology which would provide confidence intervals around the cost estimate.

b. Significance: This methodology offers potential improvement in estimating cost in the highly technological area of jet engines. Further research to replicate this study must be done before true significance can be assessed.

IV. LOGISTICS: Processes of supporting the systems in the operating inventory.

#### RELIABILITY MANAGEMENT

Area Managers: Major Lyle W. Lockwood  
Captain Paul W. Gross, Jr.

Objective: To realize system/equipment reliability that minimizes life cycle cost and achieves the required level of system effectiveness.

Background: Reliability is one of the most important operating characteristic parameters of Air Force equipment. Equipment reliability affects operational readiness, inventory levels, procurement quantities, and maintenance resources. The technical, business, and logistics dimensions of reliability are important to the acquisition process. The technical dimension must consider the design, test, and prediction factors which impact upon demonstrating weapon system reliability. The business dimension deals with the cost/benefit analysis for reliability improvement, contractual specification for reliability, and the administration of contractual reliability requirements. The procurement technique of reliability improvement warranty (RIW) is a contract methodology presently being introduced to improve system reliability. The logistics effects dimensions are concerned with inventory/supply management, maintenance, and transportation changes in the system required to accommodate warranties.

Significance: There is an important need to reduce support costs for military systems to levels which are consistent with funding limitations. The dimensions discussed above are important parameters of system life cycle cost and operational effectiveness, and they can provide fruitful areas for research. The RIW procurement technique needs to be evaluated as a contractual approach to improve reliability.

Projects Completed(\*)/In Progress:

\*1. Project Number D-1-5. "An Analysis of the Relationship of Reliability Improvement Warranties (RIW) to Interfirm Competition in DOD Avionics Procurements," Captain B. Christian and Captain M. Riely. AFIT/SL Thesis. Chairman: Lieutenant Colonel M. D. Martin.

a. Summary: The reliability improvement warranty (RIW) is a relatively new procurement concept which may potentially make a significant contribution to the Department of Defense (DOD) goal of lowering life cycle costs (LCC) of weapon systems. The LCC concept emphasizes the total ownership costs of an item over its entire useful life. The multiyear RIW contract provides a financial incentive to improve reliability of Air Force systems. One factor delaying full-scale implementation of RIW is the uncertain effects on competition. The purpose of the study was to determine and compare the degree of competition present on six RIW avionics equipment contracts and essentially similar contracts without RIW clauses. The variables used to measure the degree of competition were the number of contractors vying for contract award and the variability of the proposed prices.

b. Significance: The results of the study indicated that the degree of competition for contracts containing RIW clauses did not differ significantly from that of contracts without RIW clauses. However, certain qualifications should be considered. Only six categories of avionics items were reviewed, and these six categories may not be representative of the entire population of avionics items. Six RIW avionics contracts issued by DOD were included in the research; however, only two contracts were completed. The impact of this procurement concept cannot be completely determined. Even though the sample size was small, the research suggested that RIW was not a detriment to competition.

\*2. Project Number D-1-6. "An Analysis of USAF Depot Level Maintenance Capability to Meet Surge Requirements for Reliability Improvement Warranty (RIW) Items," Captain J. Sharp and Mr. J. C. Toshach. AFIT/SL Thesis. Chairman: Major M. McCormick.

a. Summary: The study analyzes the impact of reliability improvement warranty (RIW) contracts on the maintenance support of the C/KC-135 and C-141 inertial navigation systems (INS) in the event of a national emergency. RIW's are long-term contracts restricting repair capability of warranted items to the contractor for the duration of the warranty period. RIW's have been advanced as a useful device to obtain improved reliability by providing the contractor a

positive financial incentive to increase reliability. Historically, the government has maintained an in-house repair capability to respond in times of emergency conditions to a surge requirement. However, under RIW contracts the government does not usually maintain an in-house repair capability. The study evaluated the impact of RIW on depot level maintenance capabilities to respond to surge requirements in the event the contractor could not fully respond. A simulation of the maintenance support from the RIW contractor and government depot maintenance for the INS applicable to the C-141 and C/KC-135 aircrafts was conducted to determine if sufficient repair capability could be developed to meet anticipated surge requirements.

b. Significance: On the particular INS items used in the simulation, no problems were apparent in generating a government repair capability as long as the contract guaranteed reliability rate was achieved. However, if the guaranteed reliability rate was not achieved, INS shortages could be expected. This research indicated that lack of a government depot repair capability for surge requirements would not be a detriment to wartime support.

\*3. Project Number D-1-4. "The Effects of Renewal Processes Upon Stochastic Reliability Models," Captain L. A. Dugas, Jr., and D. H. Hartman. AFIT/SL Thesis. Chairman: Lieutenant Colonel J. Boyett.

a. Summary: Recognition of three considerations motivated this study: (1) the assumptions of constant MTBF (reliability) present in Reliability Military Standards (MIL-STD-785, Requirements for Military Programs; MIL-STD-781, Reliability Tests: Exponential Distribution; and MIL-STD-756, Reliability Prediction); (2) the problems of predicting demands and failure rates for new acquisition; and (3) the selection of an appropriate renewal policy (maintenance and procurement). Using a simulation model, this study evaluated the effect of five basic maintenance policies upon actual versus expected system reliability as steady state (essentially constant MTBF) was approached. The situation for study was: the units were composed of 10 independent components; the expected unit MTBF was 500 hours; the mature fleet size of 100 new units was delivered at the rate of 5 per month (20 months for fleet delivery); units were operated 5 hours per day; and reports were made every month for 48 months. Nine experimental units with the predicted 500 hours MTBF were defined for the study. Each unit was to exhibit one of four basic hazard functions (decreasing failure rate, increasing failure rate, or combined failure rate, i.e., bath-tub curve). From two fundamental policies, i.e., scheduled or opportunistic, five basic maintenance policies were tested: (1) Renew any

component upon failure, i.e., minimum maintenance; (2) Renew a subset of components upon failure of any component, i.e., overhaul upon failure or maximum maintenance; (3) Replace a subset of components upon termination of a fixed component operation time or component failure, i.e., time replacement of components; (4) Replace a subset of components upon termination of a fixed unit operation time or component failure, i.e., block replacement and (5) Inspect unit upon component failure and replace components approaching failure, i.e., inspection policy. Replacement upon failure (policy 1) was used throughout the experiment to keep total inventory constant and as a basis for comparison. Neither opportunistic nor preemptive maintenance policies for components with decreasing or constant hazards were examined since, logically, a degradation of failure rate would occur.

The study found that the direction and speed of approach to steady state is related to the degree of increasing or decreasing tendencies of a unit's hazard function. Further, findings indicate that multicomponent units take longer to reach steady state than single component units (see Erickson and Hammod). [ED NOTE: Similar simulation scenarios by these two studies indicate steady state MTBF for single component units is achieved in approximately 20 months and multicomponent units achieve steady state in approximately 40 months.] Primarily from the minimum maintenance policy, the study proposed two basic trends. Units with increasing and constant failure rates exhibit demand patterns which a moving average underestimates until after steady state is reached. Units with a decreasing failure rate exhibit demand patterns which rise higher than steady state and reach a peak concurrent with last equipment delivery at which time a moving average overestimates demands.

The maximum maintenance policy (policy 2) served to define the limits of failure reduction capability and a companion limit of maximum demands. This policy was judged to be unrealistic due to cost implications. This policy would be selectively applied in a situation with a high proportion of increasing failure rate components.

An examination of time replacement of component maintenance policy (policy 3) concluded that reductions in component replacement intervals may aggravate unit failure rates. The block replacement policy (policy 4) was concluded to be very effective for steeply increasing hazard units by yielding lower than predicted reliability and predictable demand patterns.

The inspection policy (policy 5) was found to yield results similar to the minimum maintenance policy (policy 1); however, by increasing the capability to detect incipient failures (100 hours versus 10 hours) there was a slight increase in unit reliability and a corresponding increase in demands.

b. Significance: Since equipment failures follow decreasing, constant, increasing, or combination failure distribution and each failure distribution has different implications, there is a need for management to determine which failure distribution is present and how long it will be before steady state is reached. In the situation where the unit has a decreasing failure rate, there is a need to refrain from preemptive actions which may increase support costs. Further, there is a need to recognize that over response to observed demand patterns coincident with the last delivery of production units may stimulate over provisioning (of parts, people or facilities) and an unwarranted distrust in long-range MTBF predictions. Awareness of having units with increasing failure rates may signal the appropriate manner of implementing a preventive replacement policy to reduce the probability of unit failure. Then there is a problem of choosing a maintenance/renewal policy. The decision is somewhat simplified in that this research showed there was little significant difference between an inspection policy (policy 5) and a minimum maintenance policy (policy 1). Consideration of opportunistic replacement of wearout components at each maintenance action may be appropriate. However, a limit does exist in the capability to reduce failure in this manner. A further consideration in the choice of an optimum maintenance policy for increasing failure rate units should include a recognition that time replacement policies may have unwanted peaks in failure rate and demands. These peaks depend on an interaction of the replacement cycle, MTBF, and the shape of the unit's hazard rate. Block replacement policies, e.g., at phase inspections, have the potential to eliminate failures almost completely, but the associated demands for replacements are extremely high in comparison to those demands generated by a minimum maintenance policy, e.g., policy 1. Knowing that the interrelationships among these unit characteristics are factors in the maintenance policy decision, logistics managers may avert an overreaction to a sudden unit increase in MTBF. More importantly, false plateaus suggesting steady state conditions may be recognized. Constant failure (theoretically stationary MTBF) units pose little management problems. Logistics support processes should quickly achieve steady state given the demands upon the system (as a function of the reliability of units) are constant.

The recognition of key failure rate characteristics (decreasing, constant, or increasing) implicit in the units can lead to policies that approach optimality and emphasizes the need for consistent and relevant information for decision making.

[ED NOTE: Several aspects of this study have implications for a variety of applications. The background section is particularly good for relating the interrelationships between maintenance policies and reliability management. For those responsible for implementing reliability military standards on new acquisitions, the study implications highlight the need to understand the assumptions of the military standards and the nature of the transient behavior of equipment reliability. There are further implications that need to be understood when defining contract requirements (Reliability Improvement Warranty Terms - MTBF growth, warranty length, incentive structure, and pipeline spares) and performance measurement criteria. The study implies that the information system for new acquisitions needs to be sensitive to transient demand patterns.]

#### Related Activities:

Ballaban, Harold S., and Bernard L. Rettner. "Guidelines for Application of Warranties to Air Force Electronic Systems," Final Technical Report, RADC-TR-76-32, ARINC Research Corporation, Annapolis, Maryland, March 1976. AD A023956.

Beeckler, C. Eugene, and Harold F. Candy. "Analysis of AMC's Use of Warranties," Final Report, APRO 507, Army Procurement Research Office, Fort Lee, Virginia, June 1975. AD A017408.

Koegel, Thomas R., and Nathan B. Mills, "An Analysis of Decision Criteria For the Selection of F-16 Reliability Improvement Incentive Alternatives," Unpublished Master's Thesis, GSM/SM/75S-4, Graduate Systems Management, Air Force Institute of Technology, Wright-Patterson AFB, Ohio, September 1975. AD A014786.

#### Research Opportunities:

What reliability prediction models are valid for application to Air Force systems acquisitions?

What are the causes of reliability growth and how can these causes be used in the structuring of incentives to yield reliability improvement?

What methodology can be used to identify equipment which should undergo redesign to improve reliability?

What information and administration systems are required to effectively manage systems reliability and how do these vary for warranty and non-warranty situations.

What model is appropriate for transitioning from a reliability warranty to organic repair?

### LIFE CYCLE COST (LCC)

Area Manager: Captain Paul W. Gross, Jr.

Objective: The objectives are twofold: first, to develop and/or evaluate the various methods and techniques to reduce life cycle costs (LCC) (e.g., reliability improvement warranty) and second, to improve methods to identify, measure, and evaluate primary LCC cost drivers during the acquisition process.

Background: The objective of LCC is to reduce ownership costs by considering both acquisition and logistics support costs in decisions made during acquisition. The availability and accuracy of such cost data normally increase from the time the requirement originates. Therefore, it may be necessary to use different techniques to evaluate LCC during various time frames depending on the availability of LCC information. Early in the cycle, it is desirable to identify the cost drivers and make trade-off decisions between the requirement and the LCC. As the requirements become firm, LCC becomes more of a criteria to evaluate the best source among competing firms. Later in the cycle, it is necessary to incorporate the factors which indicate the need for equipment repair or replacement, e.g., flying hours, operating hours, landings, age, and extent of exposure to environmental conditions. More knowledge is needed of the changing nature of data requirements, cost drivers, and cost projection techniques if the LCC concept is to be of maximum assistance.

Projects Completed(\*)/In Progress:

1. Project Number D-3-1. "An Analysis of the Relationship between Manufacturer Assembly Time and Intermediate-Level Maintenance Repair Time," Captain D. Farris and Captain R. Smith. AFIT/SL Thesis. Chairman: Lieutenant Colonel J. Boyett.

a. Summary: The Air Force weapon system managers are placing increased reliance upon the LCC estimates when evaluating the best source among competing firms; however, finding the appropriate LCC model and determining its accuracy, remains a continuing problem. Numerous LCC models have been developed for predicting logistics support costs, of which intermediate-level maintenance repair time is an important consideration. However, possibly the major problem is obtaining accurate input data elements to drive the models. The current technique of using historical data extrapolation has proven successful in some cases, yet additional improvement is required. One approach used by the team which could circumvent the utilization of historical data is the use of the manufacturer's initial assembly time to predict the intermediate-level maintenance time required to repair a unit. The purpose of this study was to evaluate the relationship between assembly time and repair time. Avionics communication-navigation units were selected as a study vehicle, and the relationship was statistically analyzed through regression analysis.

b. Significance: The results obtained failed to indicate that a significant relationship exists between manufacturer assembly time and intermediate-level maintenance repair time; therefore, the study did not provide a viable alternative to the use of historical data for predicting maintenance repair time.

### SECTION 3 - U.S. AIR FORCE ACADEMY RESEARCH

#### USAF Procurement Research Office Status Report 19 May 1976

Objective: To provide an interface between users and researchers.

Background: A number of problems faced by procurement/logistics personnel can be studied in the academic environment. Highly qualified researchers on the faculty of the Department of Economics, Geography, and Management possess the skills needed to address these problems. In recent years we have found it to be a very valuable teaching tool to structure procurement/logistics problems in such a manner that they can be studied by cadets as a part of their regular curriculum. At the same time, a number of faculty members have become interested in solving some of the more complex problems. Cadet independent study and the Cadet Summer Research Program provide vehicles by which we can assist cadets to translate theory into practice. The projects listed below are those identified for faculty and student research during the current fiscal year. Where no project completion date is referenced, an interim or final report is available, and requests for information should be directed to:

Director  
USAF Procurement Research Office  
DFEGM  
USAF Academy, Colorado 80840

Project: A Conceptual Model for Evaluating Contractor Management During Source Selection

This report provides the reader with a conceptual model for evaluating a contractor's management potential during source selection. The model is not a definitive outline of what must be done; rather, a discussion of a number of the variables that ought to be reviewed. The reader can then include only those variables most relevant to the task at hand. The model, then, should be viewed as a thought-triggering device for source selection panels to define and structure contractor management evaluation during the source selection process. The evaluation of contractor

management is divided into three major functional areas: planning, organizing, and controlling. A checklist of variables under each topic is included in the report, with examples of a numerical scoring system, a color-coded evaluation system, and a descriptive adjective evaluation system. This report should be invaluable to organizations entering into source selection. Project number is 76-1; USAFA-TR-76-6.

Researchers: Lieutenant Colonel F. Theodore Helmer  
Major Robert L. Taylor

Project: Variable Obsolescence Rates

This project is an attempt to determine if obsolescence rates for EOQ items can be calculated and utilized in the AFLC EOQ requirements computation system. Currently, AFLC uses a constant obsolescence rate for all 450,000 EOQ items; this constant rate does not take into consideration the peculiarity of some items--some have no obsolescence, while others obsolesce rapidly. Data was collected from AFLC data systems during FY-75; these data gave us the dollar value of items disposed of by AFLC over that year. At the end of FY-75, the current inventory position of these items was obtained from the EOQ master file; and we are in the process of calculating a rate of disposal for each item. By categorizing the rates by Federal Supply Class (FSC) and weapon system, we hope to be able to incorporate an obsolescence rate that more nearly indicates the true rate for each item. Projected completion date for this project is December 1976. Project number is 75-6.

Researcher: Captain Michael S. Anselmi

Project: USAF Procurement Quality

The study was designed to use opinion research to define and rank order factors which influence the quality of procurement actions in the \$100,000 to \$2,000,000 price range. Two questionnaires were mailed to procurement managers in the field. The results indicate that communication among all parties to a procurement action is most essential to insure quality. Also several environmental factors (e.g.,

case workload) were identified as well as some important educational and experience qualifications for members of the procurement team. These results now must be validated through an analysis of actual procurement actions. Project number is 76-5.

Researcher: Captain Michael W. Gaffney

Project: R&D Cost Expenditure Pattern Analysis

A general curve for monetary expenditures during the R&D phase is being developed. This is a Pearl-Reed type curve, and it is hypothesized that a rather narrow band encompasses this curve form and can be shown to apply to the general R&D process in all weapons systems acquisitions. Research work on this curve has been completed for the A-10, B-1, AWACS, Maverick, and Minuteman programs with a general confirmation of this hypothesis. Project number is 77-1.

Researcher: Major William J. Weida

Project: Improvement of Aeronautical Systems Division Inflation Forecasting Indices

Applied analytical tools of time series analysis to the problem of improving the accuracy of forecasts for inflation rates of six measures peculiar to weapon system acquisition. Suggested improvements are now being implemented by the Air Force Systems Command. Project number is 77-2.

Researcher: Major John S. Brush

Project: Procurement Productivity Indices

Productivity indices were calculated for FY-75 using the programs developed by Lieutenant Colonel Larry M. Austin, Major Donald G. Pursley, Captain Ralph H. Freeman, Lieutenant Wade D. Knight, and Lieutenant Marc A. Wooten--see USAFA-TR-74-9.

Researcher: Captain Michael S. Anselmi

## SECTION 4 - AIR FORCE CONTRACT MANAGEMENT DIVISION RESEARCH

### Introduction

The Studies and Applications Division, Management Office, Air Force Contract Management Division (AFCMD) is responsible for developing new concepts and applying innovative techniques to improve the management of this division. The four-man office initiates internal research proposals, responds to research requests, and monitors research being conducted for AFCMD by outside resources. In addition, the Studies and Applications Division recommends and assists in the implementation of new techniques, developed through research, that will improve AFCMD's effectiveness.

The projects that follow are representative of those completed by this office in the last year or are projects that are on-going at the present time. Any questions or requests for additional information should be directed to:

AFCMD/XRR  
Kirtland AFB, New Mexico 87117  
Autovon: 964-0652

### Projects

#### I. COMPLETED RESEARCH:

Project: Organizational Structure of AFCMD Field Detachments: A New Look (75-9).

Background: Within the past five years, AFCMD has increased the span of control of its plant representatives through the addition of new organizations such as Subcontract Management, Industrial Materiel Management and "Deputy Fors." While this was occurring, the Command was also experiencing a drawdown of personnel which resulted in some of the smaller AFPRO's combining other functions; e.g., Quality Assurance and Engineering. The result of these disparate trends is a lack of standardization in the organization of AFPRO's and a high probability that they are not organized in the most efficient and effective manner.

Summary: This study addresses the current structure of AFCMD field detachments in relation to generally accepted organizational theory and principles regarding types of work, organizational units and structure. In particular, the plant representative's span of control and the use of teams were studied. An alternative structure was developed which eliminated some of the weaknesses in the present detachment structure. This structure provides a standard organizational alignment for detachment top management, yet allows enough flexibility to tailor lower levels to AFPRO activities and size. In addition to a change in structure, it was recommended that a long range plan be developed to test the structure, enhance personnel capabilities, and determine the resulting impact upon the Headquarters' structure.

Researchers: Captain Wayne S. Brothers and  
Captain James A. Herrmann

## II. ON-GOING RESEARCH:

Project: Time Series Analysis of Defense Aerospace Contractor Productivity (76-1)

Background: An earlier project (74-5) explored a methodology to measure productivity or economic efficiency in the defense aerospace industry. Using 1974 fiscal year data for the twenty contractors under AFCMD cognizance, measures of economic efficiency were developed for individual contractors. One of the recommendations of Project 74-5 was to expand the scope of the analysis from a cross-section to a time series analysis.

Summary: This project will be an extension of the previous work. Comparable 1973 and 1975 fiscal year data will be collected. The measurement methodology will be applied to obtain a productivity index series for each contractor. This time series analysis will be limited to two product groupings: airframes and missile manufacturers.

Researcher: Captain M. Brian McDonald

## SECTION 5 - BIBLIOGRAPHY OF PREVIOUSLY REPORTED STUDIES

The following bibliography lists studies that have been previously reported in the Semiannual Business Research Report. The study titles are grouped by research practice as previously defined in this report. Copies of those titles followed by an "LD" or "AD" number can be obtained from DLSIE or DDC respectively (see page iv). Copies of those studies without an "LD" or "AD" number can be obtained from AFBRMC.

### BUSINESS STRATEGY

Air Combat Fighter: European Systems Program Office Management Issues and Design. N. Ohman, July 1975, A-4-1-74. AFBRMC Sponsored. Research Director: Major Michalowski.

Air Force Procurement Contracting Officer's Leadership Style: A Comparative Analysis of Measurement Instruments. J. Bennett and J. Bryant, December 1975, A-1-3-74 (AD A016039). AFIT/SL Thesis. Chairman: Mr. J. Hood.

An Analysis of Appealed Air Force Contract Disputes. P. Newman, December 1975, A-3-1-74. Central Michigan University Independent Study. Advisor: Dr. E. Gordhammer.

An Analysis of the Control and Importance of Strategy Factors in Planning for Negotiation of Procurement Contracts. H. Waldman and J. Rutledge, December 1975, A-1-4-74 (AD A016036). AFIT/SL Thesis. Chairman: Mr. J. Hood.

An Analysis of Strategy and Tactics Employed in Contract Negotiations. H. Marshall and R. Pratt, December 1974, I-1-4-74 (AD 785957). AFIT/SL Thesis. Chairman: Mr. J. Hood.

Analytic and Empirical Models of Competitive Bidding on BART Contracts. J. Zimmerman and K. Gaver, December 1975, A-2-2-75. AFBRMC Study. Research Director: Lieutenant Colonel D. E. Strayer.

The Authority Relationships of Contracting Officers in a Project/Program Management Environment. J. Block and G. Hadlow, July 1975, I-1-1-74 (AD A006338). AFIT/SL Thesis. Chairman: Mr. J. Hood.

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A Comparison of Program Office/AFPRO Acquisition Production Management Tasks. W. Goss and L. Lockwood, December 1975, B-2-1-75 (AD A016264). AFIT/SL Thesis. Chairman: Lieutenant Colonel M. D. Martin.

Criteria for Evaluating Contractor Management Potential during the Source Selection Process for the Acquisition of Major Weapon Systems. T. Cormany and J. Donnellan, July 1975, II-1-4-74 (AD A006329). AFIT/SL Thesis. Chairman: Major J. Adams.

An Evaluation of the Integrated Managerial Programming Analysis and Control Techniques (IMPACT) System of the Aeronautical Systems Division (AFSC) - A Management Information System. W. Boles and A. Bowman, December 1975 (AD A006334). AFIT/SL Thesis. Chairman: Lieutenant Colonel M. D. Martin.

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The Information Differences Between the Department of Defense-Sponsored and Civilian-Sponsored Management Information Systems. P. Ray and D. Spicer, December 1975, B-1-1-74 (AD A016388). AFIT/SL Thesis. Chairman: Major J. Adams.

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War Readiness Spares Kits (WRSK) Computation. J. Morrison and R. Probst, December 1975, C-2-4-74. AFIT/SL Thesis. Chairman: Captain B. Elwell.

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